



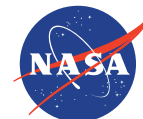
May 20, 2019

JPL Thermal Technology Portfolio

Current Developments

Ben Furst / Eric Sunada

*NASA Jet Propulsion Laboratory
California Institute of Technology*

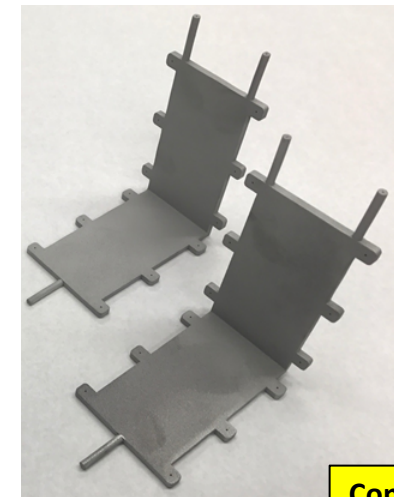
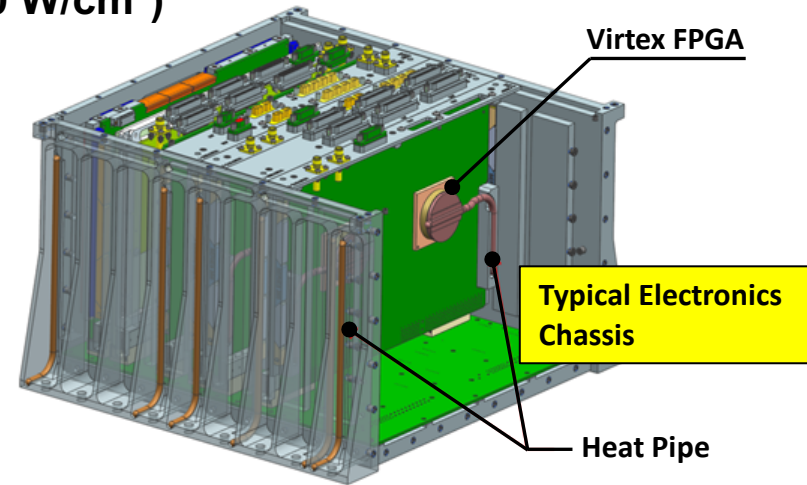
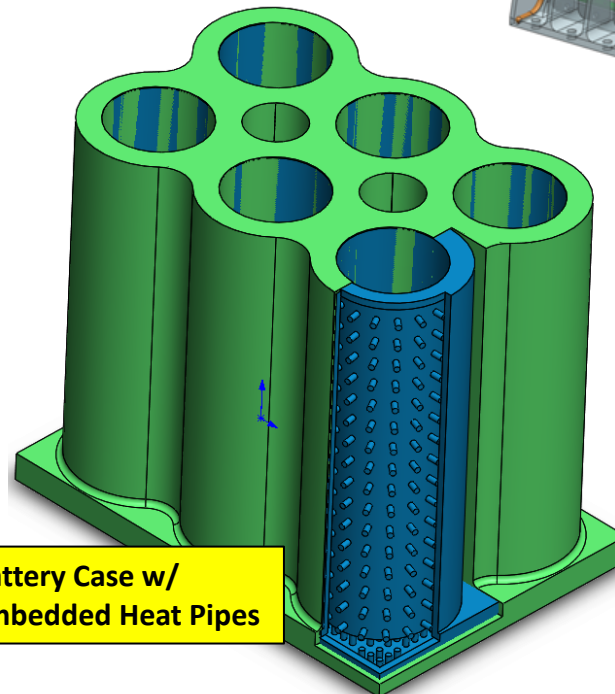
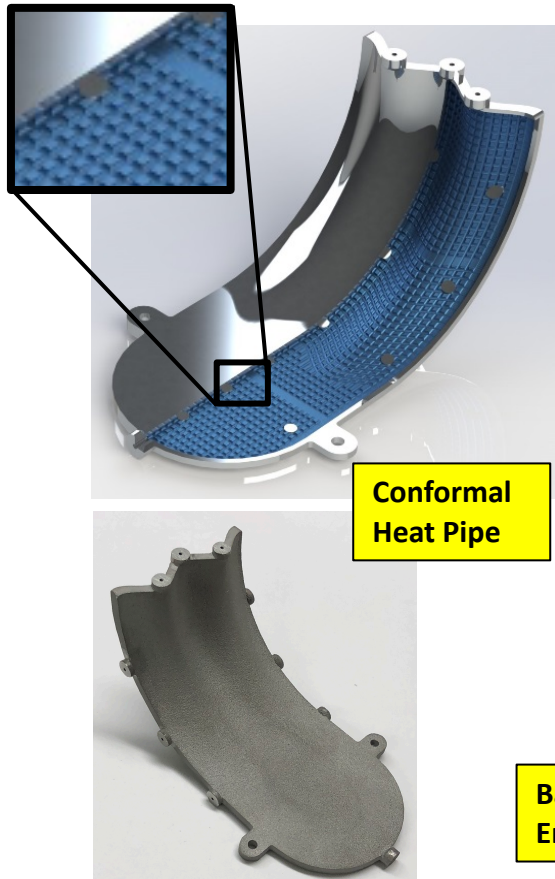


Jet Propulsion Laboratory
California Institute of Technology

Passive Two-Phase Technology

AM Heat Pipes and Oscillating Heat Pipes (OHP)

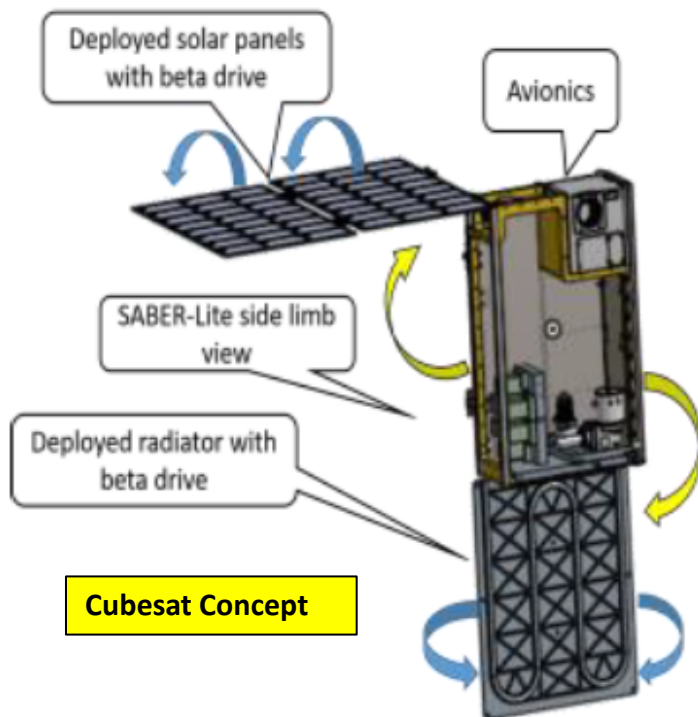
- ✓ **Embedded** directly into primary structure using AM
- ✓ **High performance** heat transfer (up to 100 W/cm^2)
- ✓ **Conformal** geometries



Active Single Phase Technology

Single-Phase Mechanically Pumped Fluid Loop

- ✓ **Scalable** from cubesats to large sats
- ✓ **Embedded** heat exchangers in primary structure using AM
- ✓ **System** level solution
- ✓ **High** TRL



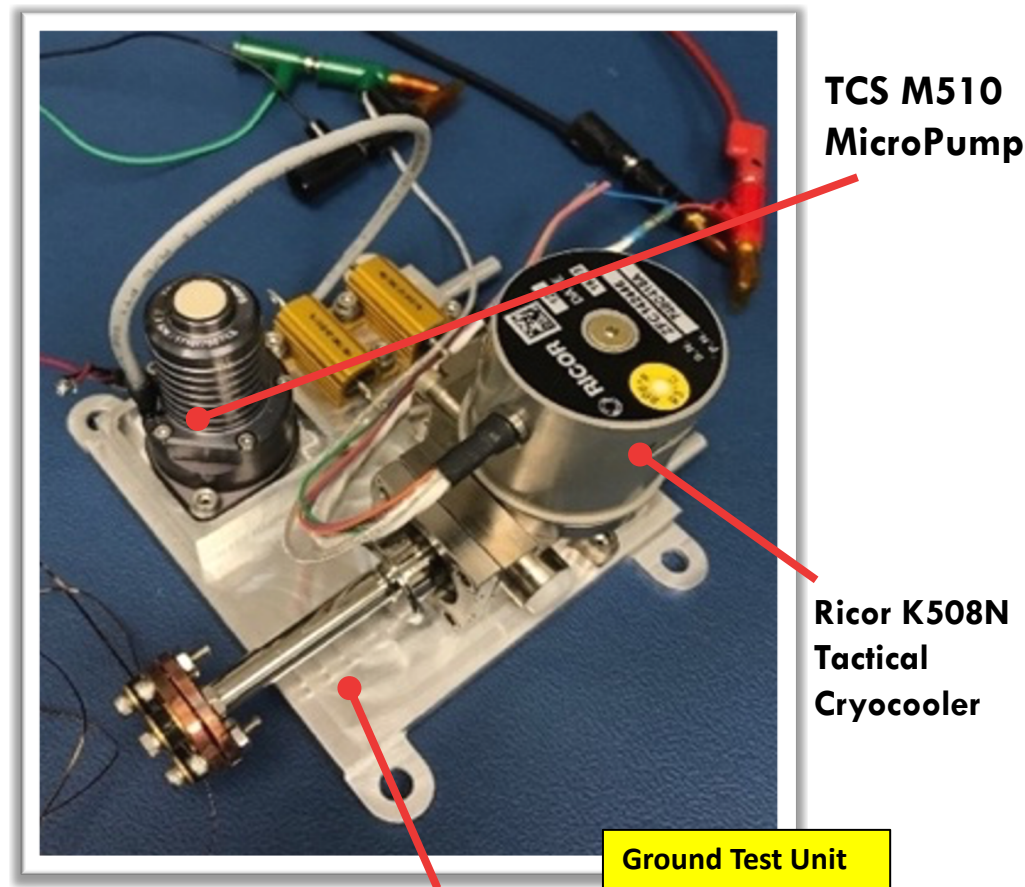
Section Contacts: AJ Mastropietro, Elham Maghsoudi

Industry and University Partners:

John Sheridan, Sheridan Solutions LLC

Mark Norfolk, Fabrisonic LLC

Dr. Charles Swenson, Utah State University

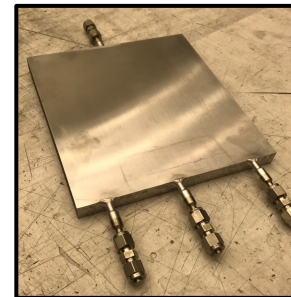
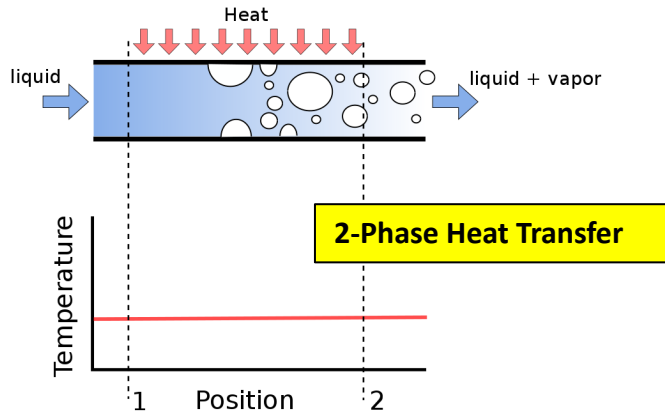


**Ultrasonic Additively Manufactured
Heat Exchanger (1Ux1U)**

Active Two-Phase Technology

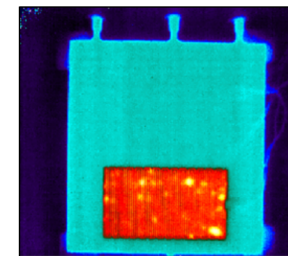
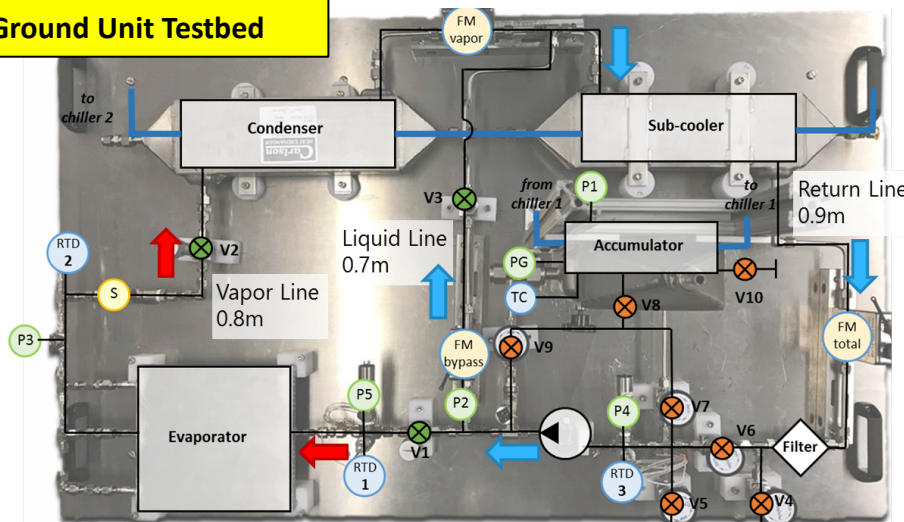
Two-Phase Mechanically Pumped Fluid Loop

- ✓ **High** performance thermal control
- ✓ **Low** mass and power requirements
- ✓ **Conformal heat** exchangers embedded in primary structure using AM

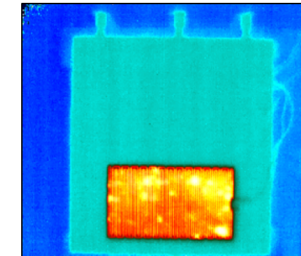


2-Phase Heat Exchangers

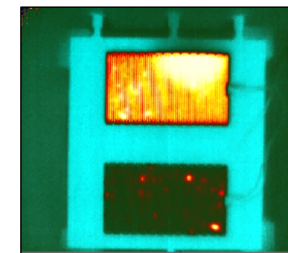
Ground Unit Testbed



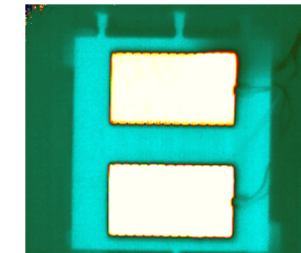
30 W



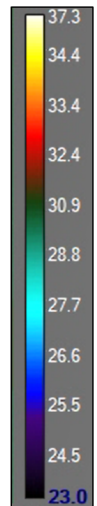
100 W



150 W
(100 W top; 50 W bottom)



325 W
(150 W top; 175 W bottom)



Test Data